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RESEARCH NOTE

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TREATMENT OF HAWAIIAN GROWN WOOD POSTS BY THE DOUBLE-DIFFUSION WOOD PRESERVATION PROCESS[1]

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INTRODUCTION

A simple method of treating fence posts against decay and termites has been developed by the U.S. Forest Products Laboratory, Madison, Wisconsin. This process is one of the newer nonpressure methods for treating wood. It consists of soaking green wood first in one chemical solution and then in a second chemical solution. The two chemicals diffuse into the wood, thus the name, "Double Diffusion." Within the wood they react to form a compound that is toxic to termites and wood-destroying fungi. Though the chemicals used are readily water soluble, the compound that forms within the wood is practically insoluble and shows little tendency to leach from the wood even under wet conditions in service.

The double-diffusion method appears to be promising for treating round wood fence posts. It should be of particular value in sections of Hawaii where commercially treated posts are not readily available, but the process is not applicable to all woods in the same degree

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1/ This study of the treatability of Hawaiian woods was done with the cooperation of the State of Hawaii Department of Agriculture and Conservation, Division of Forestry, who supplied the posts and the manpower to do the experimental treating.

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since penetration and absorption of the chemicals vary with species. It therefore seemed desirable to learn something about the treatability of Hawaiian woods. This note reports an exploratory study started in December of 1960 to learn which of the Hawaiian grown species that are suitable for fence posts in size and form and available in quantity will respond readily to this method of preservative treating.

PROCEDURE

SPECIES USED

Twelve species of native and introduced woods were treated at the State nursery of the Division of Forestry in Hilo, Hawaii. Five posts, from three or more trees, were cut as required to meet the schedule of soaking in the chemical solutions. Posts were 8 feet long and from 3 to 6 inches top diameter. The species were:

Species	No. of trees
Tropical ash, *Fraxinus uhdei*	4
Sugi, *Cryptomeria japonica*	3
Robusta eucalyptus, *Eucalyptus robusta*	3
Silk-oak, *Grevillea robusta*	3
Ohia, *Metrosideros polymorpha*	3
Saligna eucalyptus, *Eucalyptus saligna*	3
Turpentine-tree, *Syncarpia laurifolia*	4
Australian redcedar, *Toona ciliata* var. *australis*	3
Kiawe, *Prosopis* sp.	5
Norfolk-Island-pine, *Araucaria excelsa*	3
Bluegum eucalyptus, *Eucalyptus globulus*	3
Brushbox, *Tristania conferta*	3

THE TREATING SOLUTION

The chemicals used in this exploratory study, copper sulfate (the first or A solution) and sodium chromate (the second or B solution), are considered completely adequate for determining the treatability of different species, but may not be the best for exposure studies or for eventual use. For such use solution B may be a mixture of 1/2 sodium chromate and 1/2 sodium arsenate.

Solution A was prepared by dissolving 18 pounds of copper sulfate in 24 gallons of water to form a solution having a concentration of 6 percent. Two 55-gallon wooden barrels were used since copper sulfate is corrosive to steel.

Solution B was prepared by dissolving 18 pounds of sodium chromate in 26 gallons of water to form a solution having a concentration of 8 percent. Two 55-gallon steel drums were used.

PREPARING THE POSTS

All posts were cut a full 8 feet long in the field just before treating to insure completely green material. They were hand peeled and trimmed from both ends to 92 inches immediately before placing them in solution A. Each post was identified by species with a metal tag nailed to the top end.

The specific gravity of the chemical solutions was checked frequently and additional chemicals added as required to maintain the concentrations at the desired level.

THE SOAKING TREATMENT

A 3-day soaking treatment in each solution was used. By careful fitting, 20 to 24 of the peeled posts could be placed butt down in two barrels. This limitation called for treating the posts in three batches. Forty-five posts were treated in the first two batches. The remaining 15 peeled posts were treated in batch 3. In addition, 3 "extra" posts (1 ohia and 2 kiawe) with bark on were treated to see if posts could be treated without peeling. Several people, including landowners, chemical salesmen, and an operator of a treating plant, had expressed their doubts about a treating method gaining widespread use if the posts had to be peeled.

After soaking treatments, the posts were stored 2 weeks in close piles to allow the chemicals to diffuse through the wood and react to form the preservative compound. Then full cross-section discs $1\frac{1}{2}$ inches along the grain were cut from each post at a position 18 to $19\frac{1}{2}$ inches from the butt end, at 46 to $47\frac{1}{2}$ inches (center), and from 86 to $87\frac{1}{2}$ inches (top). The 3 discs from each post were numbered by post number, identified as to species and packed in a mesh bag for shipment to the Forest Products Laboratory, Madison, Wisconsin, for determination of penetration and retention of the chemicals.

ANALYSIS

Two analytical methods were used in the laboratory. Penetration was determined by spraying the cross sections with a chemical stain to show the presence of even low concentrations of copper. The penetration of chromate was estimated without a chemical stain; appreciable amounts of chromate darken the wood and can be detected readily although low concentrations may escape detection.

Retention of chemical was determined by digesting samples of groundwood with a mixture of sulfuric-nitric-perchloric acids and determining the copper and chromium in the resulting solution by standard procedures. The three discs cut from one post of each set of five were used to determine retention.

RESULTS

PENETRATION

The 12 species can be grouped in 4 treatment classes on the basis of penetration of chemical as observed in three discs per post.

Excellent Treatment

Posts of four species were found to take the chemicals readily and can be classed as excellent. These were Norfolk-Island-pine, brushbox, turpentine-tree, and saligna eucalyptus. Posts of these species had complete penetration of the sapwood in the bottom disc, complete or almost complete penetration of the sapwood in the center discs, and considerable though not always complete penetration of the sapwood in the top disc.

Norfolk-Island-pine posts had a fairly wide sapwood, up to 1 3/4 inches. The bottom disc and the middle disc were well treated, but the top disc was poorly treated. This resembles the distribution of chemicals found in southern pine posts treated by a similar schedule. Such posts generally fail because of top decay while the groundline area is still sound. Much better results are obtained if the tops are treated by inverting the posts during part of the time in solution B, or by increasing the treating time. Complete immersion in tanks should result in excellent treatment throughout if a chemical combination of copper, arsenic, and chromium is used.

Brushbox posts seemed to treat well. The bottom discs showed complete sapwood penetration. The middle discs showed only a little untreated sapwood within a ring of treated wood. The top discs varied. One post showed practically complete sapwood penetration; two others showed a ring of treated wood only 1/8 inch thick. Since the sapwood band was fairly wide--up to 1 1/4 inches--it appears likely that treating this species in tanks or in barrels with a longer schedule and by inverting the posts during part of the time in solution B should result in excellent treatment.

Turpentine-tree appeared to treat about like brushbox, though perhaps not quite so well.

Saligna eucalyptus appeared to treat about as well as brushbox.

Good Treatment

Five species were found to take the chemicals quite well and can be classed as good: silk-oak, bluegum eucalyptus, robusta eucalyptus, kiawe, and sugi. The sapwood of the bottom discs was more or less completely penetrated. The sapwood of the center discs was usually well treated, but sometimes showed considerable untreated wood. The sapwood of the top discs often showed variable amounts of penetration and sometimes very little penetration.

Silk-oak sapwood seemed to treat very well by double diffusion. The sapwood of all discs of each of the 5 posts seemed to be more or less completely penetrated. However, the sapwood was only about 3/4 inch wide and there was little or no heartwood penetration, so that as a post checked in service, the rate of decay of the heartwood would depend upon its natural durability. It appears that a good post of this species could be produced by treating by double diffusion.

Bluegum eucalyptus showed complete sapwood penetration in the bottom disc, but the middle disc showed some untreated sapwood within the ring of treated wood. The top discs were poorly treated. Complete immersion in tanks should improve the treating, and bluegum eucalyptus may be found to treat as well as those species classed excellent.

Robusta eucalyptus appears to treat about like bluegum eucalyptus, though somewhat poorer. Treating in a tank with complete immersion of the posts should result in greatly improved penetration.

Kiawe posts had narrow sapwood, but showed complete penetration of the sapwood in the bottom discs and of three of the middle discs. The top discs were poorly treated. Previous comments on inverting the posts in solution B, longer treating schedule, and complete immersion in a tank of solution apply to kiawe also. A double-diffusion treating schedule to treat the sapwood of this already durable species may greatly improve the serviceability of kiawe posts.

Sugi had well treated bottom discs, but the center discs showed incomplete sapwood penetration, and the top discs were poorly treated. Possibilities of improving the treating seem about the same as for bluegum eucalyptus, saligna eucalyptus, and kiawe.

Fair Treatment

Two species, ohia and tropical ash, could be classed as only fair. They showed incomplete penetration of the sapwood in the bottom discs, and even less penetration of the sapwood in the middle and top discs than species classed good.

In ohia, the bottom discs showed a little untreated sapwood. Treatment of the center disc was spotty. The top discs were poorly treated. The unpeeled posts seemed almost as well treated as the peeled posts.

In tropical ash, the bottom discs showed fairly good treatment although not complete sapwood penetration. The center discs showed incomplete sapwood penetration, and all top discs showed poor treatment.

Poor Treatment

Only one species, Australian redcedar, showed such poor penetration as to be classed as poor. Less than half of the sapwood was treated, even in the bottom discs.

RETENTION

Chemical analysis showed that the total amount of chemical retained in the wood was within a satisfactory range in most cases (table 1). Since copper sulfate and sodium chromate have nearly equal combining weights, a reasonably balanced uptake of the two chemicals is desired. If anything, there should be some excess of chromate to avoid corrosion of staples by unreacted copper sulfate. Several species, especially bluegum eucalyptus and Norfolk-Island-pine, proved to have absorbed deficient amounts of chromate in the part of the post that was surrounded by the solutions. A satisfactory balance was found in most species.

CONCLUSIONS

Results of this preliminary study of the treatability of Hawaiian species by the double-diffusion method were most encouraging. Several species that have good form and size for posts and are available in quantity were found to treat readily by this inexpensive, simple treating procedure. When both availability and treatability are considered, saligna eucalyptus is perhaps the most promising, followed closely by silk-oak, bluegum, and robusta eucalyptus. Minor changes in the treating schedule or using full immersion should insure good results with these four species.

Treating of unpeeled posts should be investigated further. Some species peel readily and mechanical peelers should greatly reduce the cost of this operation. Other species, however, do not peel readily. Peeling either by hand or by machine will always be an important cost consideration, and a procedure that will permit treatment of unpeeled posts will have a great advantage. Ohia in particular showed encouraging results when treated unpeeled. If a treating schedule can be developed for treating ohia without peeling, a promising use would be found for the vast supply of post-size ohia timber that is available.

Kiawe is now used extensively for posts because of its great natural durability. The sizes of posts used are large as judged by stateside standards. A schedule for treating the smaller (and usually very irregular) sizes as unpeeled posts would greatly extend the supply of posts of this species. Kiawe posts could not be peeled readily either by hand or by mechanical means because of their naturally crooked form and deeply fluted bark.

Table 1.--Chemical retained by discs from posts of Hawaiian grown wood treated by double diffusion

Species	Specific gravity 1/	$CuSO_4$		Na_2CrO_4	
		Percent	Lb. per cu. ft.	Percent	Lb. per cu. ft.
Silk-oak #5	0.615				
Top		0.005	0.002	0.02	0.01
Center		.09	.03	.06	.02
Bottom		.71	.27	.79	.30
Turpentine-tree #3	.659				
Top		.48	.20	.01	.004
Center		.37	.15	.04	.02
Bottom		1.17	.48	.76	.31
Saligna E. #2	.779				
Top		.30	.15	.12	.06
Center		.36	.18	.60	.29
Bottom		.62	.30	1.36	.66
Brushbox #1	.791				
Top		.67	.33	0	0
Center		.38	.19	.10	.05
Bottom		1.02	.50	.96	.47
Robusta E. #3	.681				
Top		.05	.02	.12	.05
Center		.16	.07	.48	.20
Bottom		.73	.31	1.11	.47
Bluegum E. #4	.926				
Top		.46	.27	0	0
Center		.42	.24	.01	.006
Bottom		.72	.42	.35	.20
Australian redcedar #3	.449				
Top		.15	.03	0	0
Center		.49	.14	.21	.06
Bottom		.79	.22	1.26	.35
Tropical ash #5	.591				
Top		.03	.01	0	0
Center		.60	.22	.03	.01
Bottom		.39	.14	.84	.31
Norfolk-Is.-pine #4	.476				
Top		.17	.05	0	0
Center		1.20	.36	.06	.02
Bottom		3.81	1.14	1.11	.33
Kiawe #5	.949				
Top		.24	.14	.02	.01
Center		.27	.16	.15	.09
Bottom		.35	.21	.43	.25

1/ See footnote at end of table. (Page 1 of 2)

Table 1.--Chemical retained by discs from posts of Hawaiian grown wood treated by double diffusion (continued)

Species	Specific gravity 1/	$CuSO_4$		Na_2CrO_4	
		Percent	Lb. per cu. ft.	Percent	Lb. per cu. ft.
Ohia #1	0.733				
Top		0	0	0	0
Center		.04	.02	.21	.10
Bottom		.44	.20	.54	.25
Sugi #5	.573				
Top		.46	.16	0	0
Center		.61	.22	.07	.02
Bottom		.85	.30	1.10	.39
Silk-oak #1	.649				
Top		.04	.02	0	0
Center		.23	.09	.35	.14
Bottom		.83	.34	1.43	.58

1/ The specific gravity values used to convert retention from percentage to the weight-per-volume (lbs. per cubic feet) were determined on three discs cut from one post of a set of five and are not necessarily average values for the species in question.